

SOIL CONSERVATION APPLICATIONS WITH C-BAND SAR

Brisco, B.¹, R.J. Brown², J. Naunheimer¹, and D. Bedard¹

¹Intera Information Technologies
2 Gurdwara Rd., Suite 200
Nepean, ON
Canada K2E 1A2
Tel: (613) 226-5442
Fax: (613) 226-5529

²Canada Centre for Remote
Sensing
2464 Sheffield Road
Ottawa, ON K1A 0Y7
Tel: (613) 952-0500
Fax: (613) 952-7353

Soil conservation programs are becoming more important as the growing human population exerts greater pressure on this non-renewable resource. Indeed, soil degradation affects approximately 10 percent of Canada's agricultural land (Dumanski et al., 1986) with an estimated loss of 6,000 hectares of topsoil annually from Ontario farmland alone (Agricultural Institute of Canada, 1980). Soil loss not only affects agricultural productivity but also decreases water quality and can lead to siltation problems. Thus, there is a growing demand for soil conservation programs and a need to develop an effective monitoring system.

Local topography, soil type, plant residue, vegetative cover, and surface roughness interact to govern soil erosion by wind and water. In general, smooth bare sandy soils are most susceptible to erosion. Contour farming, increasing crop residue and deep tillage to create enough surface roughness to break wind/water flow velocities are management techniques being used to reduce erosion risk. Topography and soil type information can easily be handled within a geographic information system (GIS). Information about vegetative cover type and surface roughness, which both experience considerable temporal change, can be obtained from remote sensing techniques. Thus all the components for a monitoring system are available.

Previous research has shown that useful information for soil conservation applications can be extracted using visible and near infra-red wavelengths (Gausman et al., 1975). Atmospheric effects and winter snow cover over much of the northern United States and

southern Canada limit the data availability in this region of the electromagnetic spectrum. Microwave systems, both active and passive, provide a reliable alternative. Recent research has demonstrated that information about residue/plant cover and surface roughness can be obtained using these types of sensors (Ulaby et al., 1986). For example, Brisco et al. (1991) found that C-Band like polarization was effective for discriminating between different tillage classes on wheat stubble fields as a function of surface roughness.

For further development of the technology to produce an operational soil conservation monitoring system an experiment was conducted in Oxford County, Ontario which investigated the separability of fall surface cover type using C-Band SAR data. This experiment obtained quantitative information on surface roughness and crop residue for about 30 fields in the study site and qualitative information on about another 250 fields.

To date only C-HH narrow swath data (6 meter resolution, 45-76 degrees incidence, 7-look amplitude format) have been analyzed. Transformed divergence separability statistics show that corn stubble can be separated into two classes (high and low stubble) and bare smooth fields can be differentiated from deep tilled fields. Confusion between bare fields and pasture or hay fields, which are also dark on the SAR imagery, could be removed with complementary optical data acquired any time earlier in the growing season. Alternatively, a GIS cover type layer could be generated from historic data as pasture and hay fields are recurring cover types on a yearly basis. This approach is proving useful for other agricultural classification purposes (Bedard et al., 1992). Corn fields that have not been harvested are also highly separable, as previous work has demonstrated (Brisco and Protz, 1980).

Transformed divergence statistics will be calculated for the other polarizations (VV, HV) and evaluated for separability of these conservation classes. Furthermore the analysis will be expanded to include multi-polarization combinations, co-polarization ratios, and cross-polarization ratios to see if improvements in class separability of conservation farming classes can be obtained with multi-polarization C-band SAR data. The results of these analyses will be related to upcoming spaceborne SAR sensors to evaluate the potential for this application using data which should be available in the next couple of years. GIS models incorporating local topography

and soil type to create an erosion potential map are also being developed. Synergism of the SAR data with visible and near-infrared channels from SPOT and TM will also be evaluated. The presentation at the AIRSAR workshop will summarize the results that have been obtained by the time of the workshop.

This research will continue with experiments already planned using ERS-1, SIR-C, and Radarsat data for further development of this application. It is envisioned that operational soil conservation monitoring systems are possible by Radarsat, or at the least by the Earth Observing System (EOS), timeframe.

References

- Agricultural Institute of Canada, 1980, "Task Force Report: Soil Erosion on Agricultural Land in Canada", Agrologist, pp. 23-28.
- Bedard, D., R. Brown, J. Naunheimer, B. Brisco, and S. Huang, 1992, "Investigating Crop Rotation Knowledge to Improve Agricultural SAR Classifications", Canadian Symposium on Remote Sensing, Toronto, ON, June 1-4, in-press.
- Brisco, B. and R. Protz, 1980, "Corn Field Identification Accuracy Using Airborne Radar Imagery", Canadian J. Remote Sensing, V.6(1), pp. 15-24.
- Brisco, B., R.J. Brown, B. Snider, G.J. Sofko, J.A. Koehler and A.G. Wacker, 1991, "Tillage Effects on the Radar Backscattering Coefficient of Grain Stubble Fields", Int. J. Remote Sensing, V. 12(11), pp. 2283-2298.
- Dumanski, J., D.R. Coote, G. Lucuik, and C. Lok, 1986, "Soil Conservation in Canada", Journal of Soil and Water Conservation, V. 41, pp. 204-210.
- Gausman, H.W., A.H. Gerbermann, C.L. Wiegand, R.W. Leamer, R.R. Rodriguez and J.R. Noriega, 1975, "Reflectance Differences Between Crop Residues and Bare Soils", Soil Science Society of America Proceedings, V. 39, pp. 752-755.
- Ulaby, F.T., R.K. Moore, and A.K. Fung, 1986, "Microwave Remote Sensing: Active and Passive, V. III: From Theory to Applications", Artech House, Inc., Dedham, MA.